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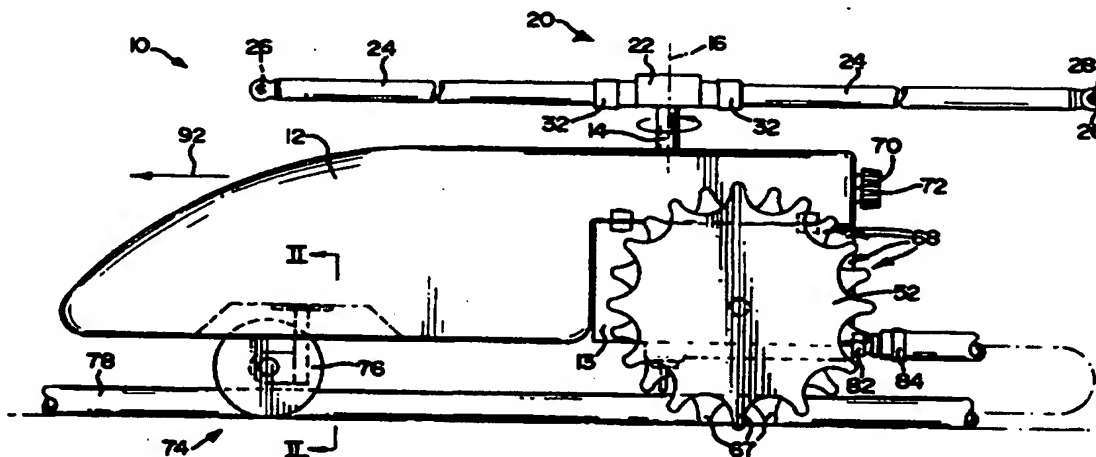
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(54) Title: WATERING APPARATUS



(57) Abstract

Watering apparatus (10) includes a chassis (12) and a sprinkler head (20) rotatably mounted for rotation about an axis of rotation (16). The sprinkler head (20) includes a pair of reaction outlets (26) spaced from the axis of rotation (16) and directed so as to cause rotation of the head (20) about the axis of rotation (16) when water is discharged therefrom. The sprinkler head (20) is connectable to a pressurised supply of water by means of a hose pipe (78). The apparatus (10) includes a pair of wheels (52) mounted on the chassis (12) and configured such that, in use, when driven they serve to propel the watering apparatus (10) along the ground. Drive from the rotating sprinkler head (20) to the wheels (52) is via a gearbox (13). At least one bleed opening leads from the head (20) to permit the volume of water flowing through the outlets (26) and hence the speed at which the apparatus is driven to adjusted.

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WATERING APPARATUS

THIS INVENTION relates to watering apparatus.

According to one aspect of the invention there is provided watering apparatus which includes

5 a chassis;

a sprinkler head rotatably mounted for rotation about an axis of rotation, the sprinkler head including at least one reaction outlet spaced from the axis of rotation and directed so as to cause rotation of the head about the axis of rotation when
10 water is discharged therefrom;

connecting means whereby the sprinkler head is connectable in flow communication with a pressurised supply of water;

at least one drivable ground engaging element mounted
15 on the chassis and configured such that, in use, when driven it serves to propel the watering apparatus along the ground;

drive means whereby the sprinkler head is drivingly connected to the ground engaging element such that the rotation of the sprinkler head about the axis of rotation serves to drive
20 the ground engaging element; and

at least one bleed outlet positioned upstream of the reaction outlet.

The head may include at least two reaction outlets equiangularly spaced about the axis of rotation.

25 The head may include a hollow central member and a pair of tubular arms connected at their one ends to and in flow communication with the central member and protruding therefrom in opposite directions, the reaction outlets being positioned at or towards the free ends of the arms.

The reaction outlets may be defined by nozzles mounted on the arms and configured such that, in use, water is discharged from each nozzle at an angle to the axis of the associated arm so as to cause a turning moment to rotate the head about the axis
5 of rotation.

The angle at which water is discharged may be adjustable. In a preferred embodiment of the invention, the angular orientation of the arms relative to the central member is adjustable to permit adjustment of the angle of the nozzles
10 and the angle at which water is discharged. By varying the angle of the nozzles, the area watered by the sprinkler can be varied.

The central member and arms may be provided with complementary locating formations configured to permit the arms to be secured to the central member in a plurality of
15 predetermined angularly spaced apart orientations.

The drive means may include a reduction gear train.

In a preferred embodiment of the invention, the reduction gear train includes at least two worm gear sets.

The sprinkler head may be mounted on and connected in
20 flow communication with a tubular spindle which is rotatably mounted on the chassis and which defines the axis of rotation, the connecting means including means defining a flow passage, one end of which is connected in flow communication with the spindle and hence with the outlets and the other end of which is
25 connectable to a pressurised supply of water. Said other end of the flow passage may terminate in a coupling member to which a water supply conduit, e.g. a hose pipe, is connectable. In a preferred embodiment of the invention, the coupling member may be in the form of a quick-release coupling member which is
30 releasably engageable by a complementary coupling member mounted on the water supply conduit.

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The bleed outlet may open out of the head, the watering apparatus including regulating means for regulating the volume of water flowing through the bleed outlet, in use.

The regulating means may include a cover element
5 displaceably mounted on the head for displacement between at least two operative positions in which it restricts the flow of water flowing through the bleed outlet to a different extent. Hence, the bleed outlet and the adjustable regulating means together form speed control means configured to permit the flow
10 of water to the reaction outlet or outlets and hence the speed with which the apparatus is propelled to be adjusted.

The apparatus may include steering means. The steering means may include a guide follower mounted on the chassis and configured to follow a guide extending along the intended path
15 of travel of the apparatus.

When intended for horticultural applications, the guide will typically be a hose pipe, the guide follower then including a pair of transversely spaced wheels mounted castor-fashion to the chassis, the spacing between the wheels being such that a
20 hose pipe is snugly receivable therebetween.

The apparatus may include flow cut-off means configured to interrupt the flow of water to the head when the apparatus reaches a predetermined position.

The ground engaging element may be in the form of a
25 drive wheel mounted for rotation about a wheel axis the drive wheel having two sets of circumferentially spaced outwardly protruding teeth-like formations, the teeth-like formations in one set being circumferentially staggered relative to the teeth-like formations in the other set.

30 According to another aspect of the invention there is provided watering apparatus which includes
a chassis;

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a sprinkler head mounted on the chassis and connectable to a pressurised supply of water;

at least one drive wheel rotatably mounted on the chassis for rotation about a wheel axis, the drive wheel having two sets
5 of circumferentially spaced outwardly protruding teeth-like formations, the teeth-like formations in one set being circumferentially staggered relative to the teeth-like formations in the other set.

In a preferred embodiment of the invention, the
10 apparatus includes a pair of drive wheels connected to the chassis at transversely spaced apart positions.

Each wheel may include an axially inner set of teeth-like formations, an axially outer set of teeth-like formations spaced axially from the axially inner set of teeth-like
15 formations and an intermediate set of teeth-like formations positioned between the axially inner and outer sets of teeth-like formations.

The intermediate set of teeth-like formations includes two diametrically opposed teeth-like formations.

20 The invention will now be described, by way of example, with reference to the accompanying diagrammatic drawings.

In the drawings,

Figure 1 shows a side view of a watering apparatus in accordance with the invention;

25 Figure 2 shows a sectional elevation taken at II-II in Figure 1;

Figure 3 shows a plan view of a sprinkler head of the apparatus of Figure 1;

Figure 4 shows an exploded sectional view of part of the
30 sprinkler head;

Figure 5 shows a sectional side view of part of the apparatus;

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Figure 6 shows a sectional elevation taken at VI-VI in Figure 5;

Figure 7 shows a three-dimensional view of a device used to interrupt the flow of water to the sprinkler head;

5 Figures 8 and 9 shows sequentially the steps involved in interrupting the flow of water to the sprinkler head;

Figure 10 shows a three-dimensional exploded view of a wheel of the watering apparatus;

Figure 11 shows a three-dimensional partly exploded view of 10 part of another sprinkler head; and

Figure 12 shows a bottom view of a cover of the sprinkler head of Figure 11.

In the drawings, reference numeral 10 refers generally to watering apparatus in accordance with the invention.

15 The watering apparatus 10 includes a chassis comprising a hollow body 12 and a gearbox housing 13 mounted on the body 12. The watering apparatus 10 further includes a spindle 14 rotatably mounted on the chassis for rotation about a vertically extending axis of rotation 16. The spindle 14 is tubular and an 20 operatively lower end thereof is rotatably supported in a complementary socket formation 18 (Figure 5).

The apparatus 10 further includes a sprinkler head 20 mounted on the upper end of the spindle 14 in flow communication therewith. The sprinkler head 20 comprises a hollow central 25 member 22 and a pair of tubular arms 24 connected to the central member 22 and protruding therefrom in opposite directions. A nozzle 26 is mounted on the free end of each tubular arm 24 and defines a reaction outlet 28. The operatively inner end of each arm 24 is receivable in a socket formation 30 forming part of the 30 central member 22 and is secured therein by means of a locking nut 32. A plurality, e.g. three, longitudinally extending circumferentially spaced notches or recesses 34 (Figure 3) is provided in the inner end of each tubular arm 24 with a complementary keying formation or protrusion 36 (Figure 4) being 35 provided in each socket formation 30 so as to locate the

associated tubular arm 24 in one of a number of predetermined angular orientations.

The central member 22 comprises a hollow base 38 from which the socket formations 30 protrude. The base 38 has a
5 downwardly depending internally threaded socket 40 which is screwed onto the uppermost end of the spindle 14 so as to connect the interior of the base 38 in flow communication with the spindle 14. An aperture or bleed outlet 42 (shown in broken lines in Figure 3 of the drawings) opens out of an upper surface
10 of the base 38 and a cover 44 is mounted on the base 38 and secured in position by a screw 45 such that it is rotatable relative thereto between three predetermined positions which regulate the rate of flow of water through the aperture 42. With the cover 44 in the position shown in Figure 3 of the drawings,
15 the aperture 42 is completely closed off and no flow is permitted. In a second position, a single hole 46 is brought into register with the aperture 42 so as to permit limited flow through the cover 44. In the third position, two holes 48 are brought into register with the aperture 42 so as to permit an
20 increased rate of flow through the cover 44. It is to be appreciated, that in the second and third positions of the cover 44, the volume of water being discharged through the nozzles 26 will decrease by the amount of water which is being discharged through the holes in the cover. A resilient pin 50 mounted on
25 the cover 44 cooperates with complementary recesses on the base 38 so as to retain the cover releasably in one of its three operative positions described above.

The nozzles 26 are angled relative to the axes of the tubular arms 24 such that in use a turning moment is created
30 which serves to rotate the sprinkler head 20 about the axis of rotation 16.

Reference is now made to Figures 11 and 12 of the drawings, in which reference numeral 120 refers generally to another sprinkler head and, unless otherwise indicated, the same
35 reference numerals used above are used to designate similar

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parts. The sprinkler heads 20 and 120 function in more or less the same manner. One difference between the sprinkler head 120 and the sprinkler head 20 is that an annular collar 122 is provided on each tubular arm 24 adjacent an innermost end thereof. Further, a keying formation or protrusion 124 protrudes radially outwardly from the radial outer surface of the tubular arm 24 adjacent the collar 122. Three complementary circumferentially spaced apart notches or recesses (not shown) are provided at the mouth of the socket formation 30 so that the keying formation 124 is receivable in one of the notches to locate the arm 24 in one of a number of predetermined angular orientations. The collar 122 is urged into abutment with the socket formation 30 by means of the locking nut 32 thereby securing the tubular arm 24 releasably in the desired position.

15 In this embodiment of the invention, the base 38 includes a circular member from which an internally threaded socket (not shown) similar to the socket 40 of the sprinkler head 20 depends. A peripheral skirt 128 protrudes upwardly from the circular member 126. A centrally disposed aperture 130 extends through the circular member 126. A tubular protrusion 132 protrudes upwardly from the circular member 126. The protrusion 132 is connected in flow communication with the socket and the upper end of the protrusion 132 defines the bleed outlet 42. A seal in the form of an O-ring 134 is mounted in a complementary recess in the upper end of the protrusion 132 such that it surrounds the bleed outlet 42. A retaining pin 136 protrudes upwardly from the circular member 126 at a position which is diametrically opposite the protrusion 132.

30 The cover 44 includes a circular top 138 from which a peripheral skirt 140 depends. A centrally disposed circular cylindrical lug 142 depends downwardly from an inner surface of the top 138 so that when the cover 44 is positioned on the base 38, the lug is in register with and extends at least partway through the aperture 130.

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Three equiangularly spaced recesses 142 are provided in the inner surface of the top 138 and are shaped to cooperate with the retaining pin 136 to retain the cover 44 releasably in one of three predetermined positions. The cover 44 is retained 5 in position on the base 38 by means of a screw 144 which is screwed into the lug 142 from below the base 38.

In the manner described above, the cover 44 is displaceable relative to the base 38 between three predetermined positions which regulate the rate of flow of water through the 10 bleed outlet 42, the retaining pin 136 serving to retain the cover 44 releasably in the selected predetermined position. Further, the O-ring 134 sealingly abuts against the lower surface of the top 138 thereby providing a seal between the cover 44 and the base 38.

15 The apparatus 10 includes a pair of ground engaging wheels 52 which are mounted on a drive shaft 54 which in turn is rotatably mounted on the gearbox housing 13.

Drive is transmitted from the sprinkler head 20 via the spindle 14 and a gear train, generally indicated by reference 20 numeral 56 to the drive shaft 54. The gear train includes a first worm gear set comprising a worm gear 58 formed integrally with the spindle 14 and a worm wheel 60 mounted on a shaft 62 which is rotatably mounted on the gearbox housing 13. The gear train 56 further includes a second worm gear set comprising a 25 worm gear 64 mounted on the shaft 62 and drivingly engaging a worm wheel 66 mounted on the drive shaft 54. In this way a substantial reduction ratio can be obtained.

Each of the wheels 52 comprises two sets, namely an axially inner set and an axially outer set, of circumferentially 30 spaced apart alternating teeth-like formations 67 and recesses 68 with the teeth-like formations and recesses in each set being circumferentially staggered thereby providing the wheel 52 with the appearance of a pair of axially spaced apart sprocket wheels with their teeth being staggered relative to one another. Two

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circumferentially spaced teeth-like formations 69 are positioned between the portions of the wheels on which the teeth-like formations 67 and recesses 68 are provided, the formations 69 being configured, in use, to reduce wheel spin on sand by lightly
5 compacting it.

As can best be seen in Figure 10 of the drawings, each wheel 52 is made up of two parts, namely, an inner part 110 and an outer part 112. The inner and outer parts 110, 112 are formed as mouldings of a synthetic plastics material. The axially inner
10 teeth-like formations 67 and recesses 68 are provided on the inner part 110 and the axially outer teeth-like formations 67 and recesses 68 are provided on the outer part 112.

A sleeve 114 protrudes axially from an axially outer surface of the inner part 110 and is snugly receivable in a
15 complementary socket 115 which protrudes axially from an axially inner surface of the outer part 112. A plurality of circumferentially spaced fingers 116 protrude from the axially inner surface of the outer part 112. Each finger 116 has a radially outwardly facing slot 118 formed therein adjacent to its
20 free end. Complementary circumferentially spaced apertures 120 are provided in the inner part 110 through which apertures the fingers 116 protrude such that the slots 118 snap lockingly engage the surfaces of the inner part 110 defining the radially outer edges of the apertures 120 thereby retaining the inner part
25 110 and outer part 112 releasably in an assembled condition.

The teeth-like formations 69 of the intermediate set are formed by axially extending two diametrically opposed teeth-like formations 67 of the outer part 112. The assembled wheel 52 is mounted on a drive shaft which is positioned in the sleeve
30 114 such that the wheel 52 rotates together with the drive shaft.

The body 12 is hollow and is provided with a filler opening 70 through which ballast, e.g. water, can be introduced into the body 12. A cap 72 is removably mounted on the filler opening 70.

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The apparatus 10 includes steering means in the form of a guide follower, generally indicated by reference numeral 74. The guide follower 74 comprises a pair of wheels 76 which are connected to the body 12 castor-fashion so that they can swivel 5 relative thereto. The spacing between the inner surfaces of the wheels 76 is such that a hose pipe 78 or other guide line is snugly receivable therebetween.

The apparatus includes a flow passage 80 one end of which is connected to the socket formation 18 and hence in flow 10 communication with the spindle 14 and the other end of which terminates in a quick-release coupling 82 which is releasably engageable by a complementary coupling member 84 mounted on a water supply conduit such as a hose pipe 78. A coupling member 82 and complementary coupling member 84 will typically be of the 15 type which is available in South Africa under the Trade Marks "GARDENA" or "HOSE LOK".

The apparatus 10 includes a flow cut-off valve, generally indicated by reference numeral 86 for interrupting the flow of water from the flow passage 80 into the spindle 14. The 20 flow cut-off valve 86 comprises a circular closure member 88 which is positioned in the flow passage 80 and is displaceable between an open condition (shown in Figures 5 and 8 of the drawings) in which it permits flow through the flow passage into the spindle and a closed condition (shown in Figure 9 of the 25 drawings) in which it inhibits flow through the flow passage into the spindle, and an operating pin 90 which is connected to the closure member 88 and extends sealingly through a hole in the gearbox housing 13 such that it protrudes downwardly therefrom. Hence, displacement of the closure member between its normally 30 open and its closed conditions is achieved by displacement of the pin 90 as described in more detail herebelow.

In use, one end of a hose pipe 78 is connected to a pressurised water supply, e.g. a mains water supply, and the other end is connected to the coupling member 82. The hose pipe 35 is laid out along the path which it is desired the watering

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apparatus 10 should follow. The watering apparatus is then positioned such that the hose pipe extends between the wheels 52 and the wheels 76. With the flow cut-off valve 86 in its open condition, water is supplied through the hose pipe 78 to the watering apparatus 10. The water flows in the direction of arrow 91 through the flow passage 80 and the spindle 14 into the sprinkler head 20, 120. The water is discharged through the nozzles 26 which serves to rotate the sprinkler head 20, 120 and the spindle 14 about the axis of rotation 16. This rotation of the sprinkler head 20, 120 is converted into rotation of the wheels 52 by means of the gear train 56 which serves to propel the watering apparatus 10 forwardly in the direction of arrow 92. The wheels 76 follow the hose pipe 78 thereby watering a predetermined area, e.g. of a garden, the hose pipe then, for example, being positioned such that it extends between flower beds.

The volume of water being discharged from the nozzles 26 depends inter alia on the position of the cover 44. Hence, with the cover 44 in its first position all of the water is discharged from the nozzles thereby maximising the speed with which the sprinkler head 20, 120 rotates and hence the speed with which the watering apparatus 10 is propelled. When the cover 44 is in its second position, some of the water entering the sprinkler head is discharged through the hole 46 and hence less water is discharged from the nozzles 26 thereby reducing the speed with which the sprinkler head 20, 120 rotates and hence the speed with which the watering apparatus 10 is propelled. The hole 46 is typically configured so as to spray the water in a circular discharge pattern thereby increasing the volume of water which is discharged in a particular area. The width of the area being watered can also be adjusted by adjusting the angular orientation of the tubular arms 24 and hence of the nozzles 26. This results in the trajectory of water exiting the nozzles 26 being varied and hence the distance travelled by the water being varied. Hence, by selecting the appropriate position of the cover 44 and the angular orientation of the arms, the desired watering intensity can be obtained.

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In order to interrupt the flow of water to the sprinkler head 20, 120 at a desired location, use is made of a ramp member, generally indicated by reference numeral 96 (Figures 7 to 9 of the drawings). The ramp member 96 comprises a pair of 5 transversely spaced apart ramp formations 98 which are connected together by means of connecting pieces 100. The spacing between the ramp formations 98 is such that the hose pipe 78 is snugly receivable therebetween. The ramp formations have a height which is slightly greater than the outer diameter of the hose pipe 78. 10 The ramp member 96 is positioned on the ground and the hose pipe is positioned between the ramp formations.

In use, when the wheels 76 encounter the ramp formations they simply roll over them. However, the pin 90 is positioned to engage one of the ramp formations such that when 15 it abuts there against it is urged upwardly displacing the closure member 88 from its open towards its closed condition. Once the closure member 88 begins to move from its open towards its closed condition, the pressure of water acting thereon serves to urge it towards its closed condition and retain it in that 20 position (Figure 9) thereby interrupting the flow of water from the flow passage 80 to the spindle and hence the sprinkler head 20, 120. This interrupts the drive to the wheels 52 causing the watering apparatus 10 to stop.

The watering apparatus 10 and ramp member 96 will 25 typically be sold together, e.g. in the form of a kit and the invention accordingly extends to a kit including these components.

The Applicant believes that watering apparatus 10 in accordance with the invention will be relatively convenient to 30 use and will be capable of watering relatively large areas of garden. A major advantage of the apparatus is that it switches itself off thereby avoiding wastage of water when the required area has been watered.

Further, the Applicant believes that the particular configuration of the wheels 52 will permit the watering apparatus to traverse varying types of terrain.

In addition, the Applicant believes that watering
5 apparatus in accordance with the invention will be producible at a price which will render it suitable as a viable alternative to permanent sprinkler installations and the like.

The Applicant believes that substantially all of the components of the watering apparatus 10 can be manufactured from
10 a synthetic plastics material thereby virtually eliminating any corrosion problems and improving the reliability of the apparatus.

A further advantage is that by varying the positions of the arms 24 and the cover 44, the speed of the apparatus and
15 the watering intensity can be accurately controlled thereby rendering the apparatus particularly suitable for use on bowling greens and the like.

CLAIMS

1. Watering apparatus which includes
 a chassis;
 a sprinkler head rotatably mounted for rotation about
5 an axis of rotation, the sprinkler head including at least one
 reaction outlet spaced from the axis of rotation and directed so
 as to cause rotation of the head about the axis of rotation when
 water is discharged therefrom;
 connecting means whereby the sprinkler head is
10 connectable in flow communication with a pressurised supply of
 water;
 at least one drivable ground engaging element mounted
 on the chassis and configured such that, in use, when driven it
 serves to propel the watering apparatus along the ground;
15 drive means whereby the sprinkler head is drivingly
 connected to the ground engaging element such that the rotation
 of the sprinkler head about the axis of rotation serves to drive
 the ground engaging element; and
 at least one bleed outlet positioned upstream of the
20 reaction outlet.
2. Watering apparatus as claimed in claim 1, in which the
 head includes at least two reaction outlets equiangularly spaced
 about the axis to rotation.
3. Watering apparatus as claimed in claim 2, in which the
25 head includes a hollow central member and a pair of tubular arms
 connected at their one ends to and in flow communication with the
 central member and protruding therefrom in opposite directions,
 the reaction outlets being positioned at or towards the free ends
 of the arms.
- 30 4. Watering apparatus as claimed in claim 3, in which the
 reaction outlets are defined by nozzles mounted on the arms and
 configured such that, in use, water is discharged from each
 nozzle at an angle to the axis of the associated arm so as to

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cause a turning moment to rotate the head about the axis of rotation.

5. Watering apparatus as claimed in claim 4, in which the angle at which water is discharged, from the nozzles is adjustable.
6. Watering apparatus as claimed in claim 5, in which the angular orientation of the arms relative to the central member is adjustable to permit adjustment of the angle of the nozzles and the angle at which water is discharged.
- 10 7. Watering apparatus as claimed in claim 6, in which the central member and arms are provided with complementary locating formations configured to permit the arms to be secured to the central member in a plurality of predetermined angularly spaced apart orientations.
- 15 8. Watering apparatus as claimed in any one of the preceding claims, in which the drive means includes a reduction gear train.
9. Watering apparatus as claimed in claim 8, in which the reduction gear train includes at least two worm gear sets.
- 20 10. Watering apparatus as claimed in any one of the preceding claims, in which the sprinkler head is mounted on and connected in flow communication with a tubular spindle which is rotatably mounted on the chassis and which defines the axis of rotation, the connecting means including means defining a flow
25 passage, one end of which is connected in flow communication with the spindle and hence with the outlets and the other end of which is connectable to a pressurised supply of water.
11. Watering apparatus as claimed in any one of the preceding claims, in which the bleed outlet opens out of the
30 head, the watering apparatus including regulating means for

regulating the volume of water flowing through the bleed outlet, in use.

12. Watering apparatus as claimed in claim 11, in which the regulating means includes a cover element displaceably mounted
5 on the head for displacement between at least two operative positions in which it restricts the flow of water flowing through the bleed outlet to a different extent.
13. Watering apparatus as claimed in any one of the preceding claims, which includes steering means.
- 10 14. Watering apparatus as claimed in claim 13, in which the steering means includes a guide follower mounted on the chassis and configured to follow a guide extending along the intended path of travel of the apparatus.
15. Watering apparatus as claimed in claim 14, in which the
15 guide follower includes a pair of wheels spaced apart transversely such that a hose pipe is snugly receivable therebetween.
16. Watering apparatus as claimed in any one of the preceding claims, which includes flow cut-off means configured
20 to interrupt the flow of water to the head when the apparatus reaches a predetermined position.
17. Watering apparatus as claimed in any one of the preceding claims, in which the ground engaging element is in the form of a drive wheel mounted for rotation about a wheel axis,
25 the drive wheel having two sets of circumferentially spaced outwardly protruding teeth-like formations, the teeth-like formations in one set being circumferentially staggered relative to the teeth-like formations in the other set.
18. Watering apparatus which includes
30 a chassis;

a sprinkler head mounted on the chassis and connectable to a pressurised supply of water;

at least one drive wheel rotatably mounted on the chassis for rotation about a wheel axis, the drive wheel having two sets
5 of circumferentially spaced outwardly protruding teeth-like formations, the teeth-like formations in one set being circumferentially staggered relative to the teeth-like formations in the other set.

19. Watering apparatus as claimed in claim 17 or claim 18,
10 which includes a pair of drive wheels connected to the chassis at transversely spaced apart positions.

20. Watering apparatus as claimed in any one of claims 17 to 19, inclusive, in which each wheel includes an axially inner set of teeth-like formations, an axially outer set of teeth-like
15 formations spaced axially from the axially inner set of teeth-like formations and an intermediate set of teeth-like formations positioned between the axially inner and outer sets of teeth-like formations.

21. Watering apparatus as claimed in claim 20, in which the
20 intermediate set of teeth-like formations includes two diametrically opposed teeth-like formations.

22. New watering apparatus substantially as described and illustrated herein.

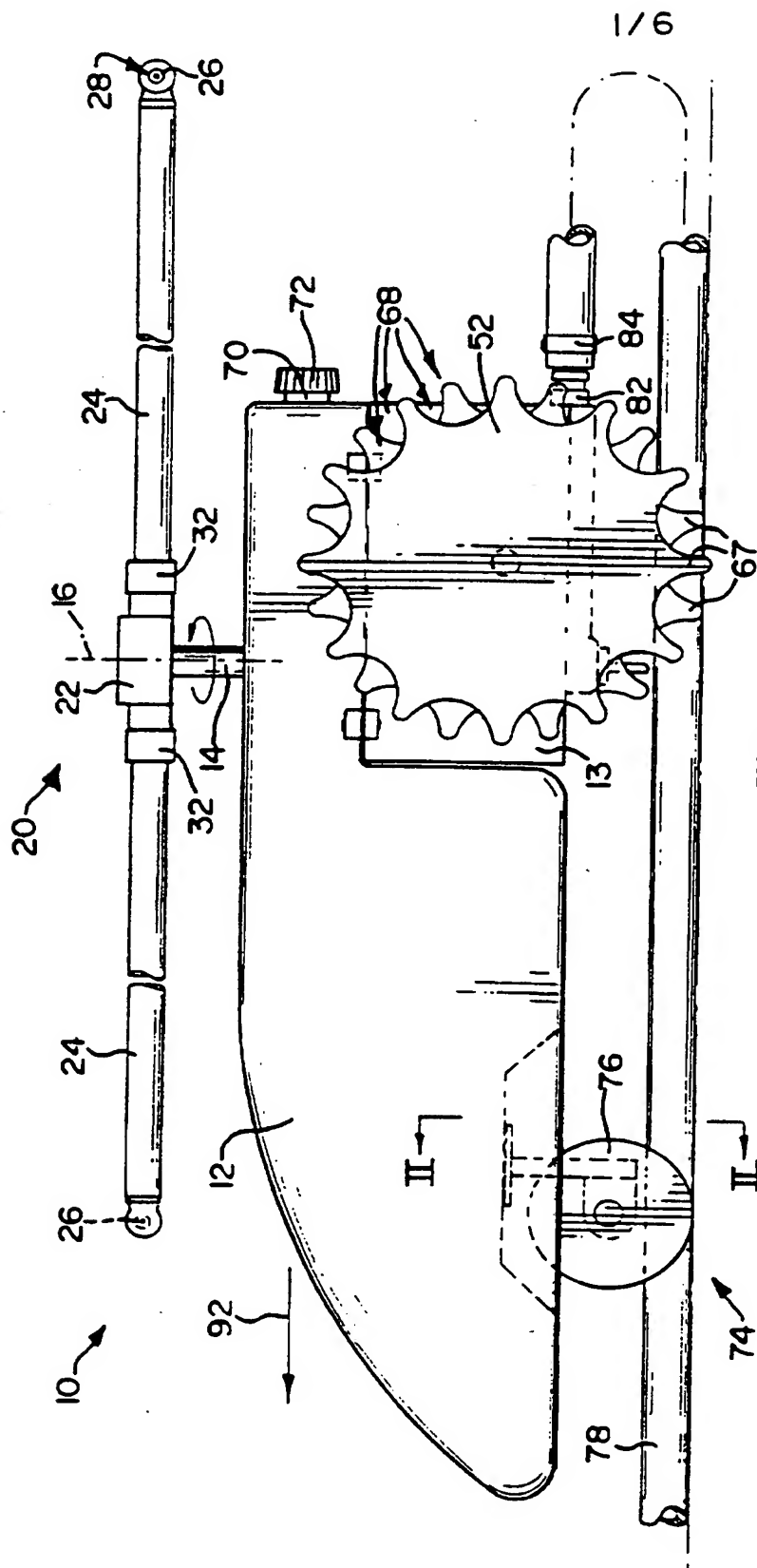


FIG 1

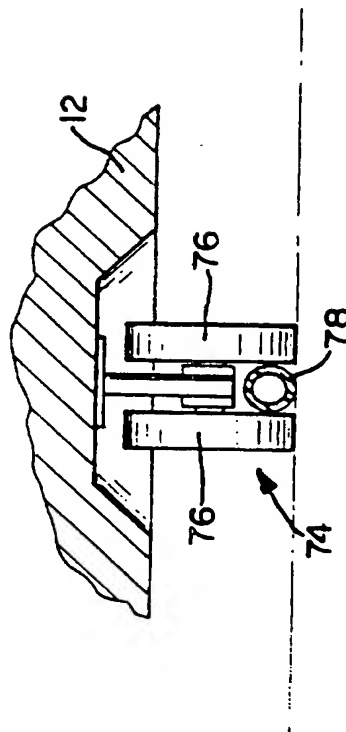


FIG 2

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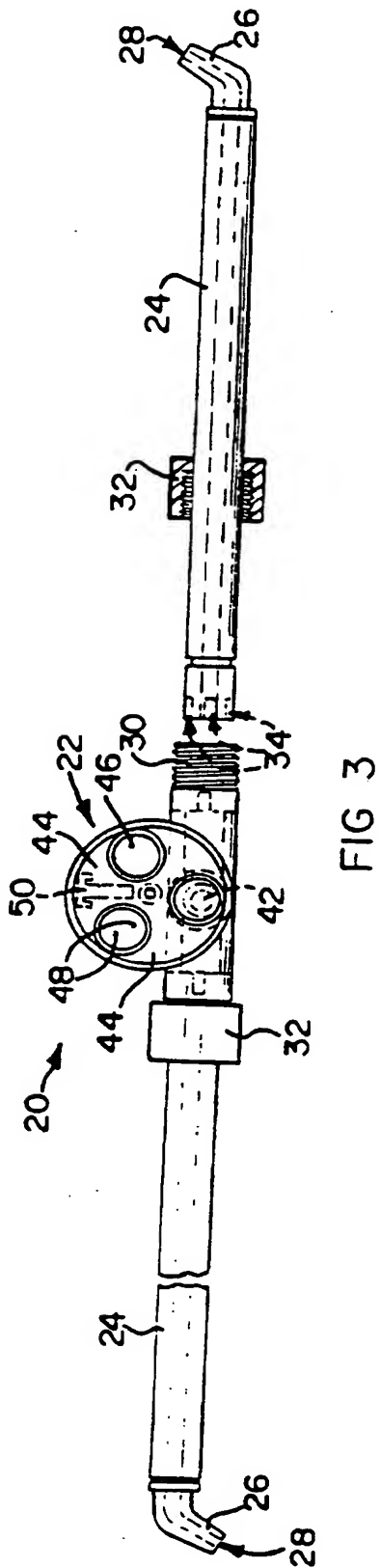


FIG 3

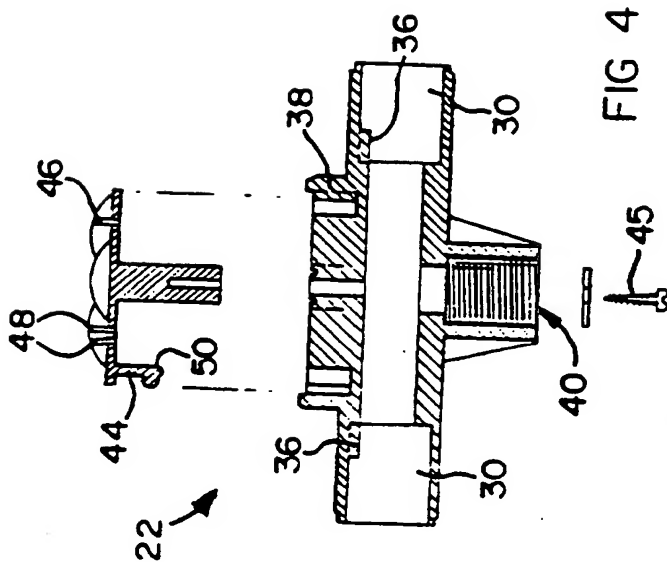
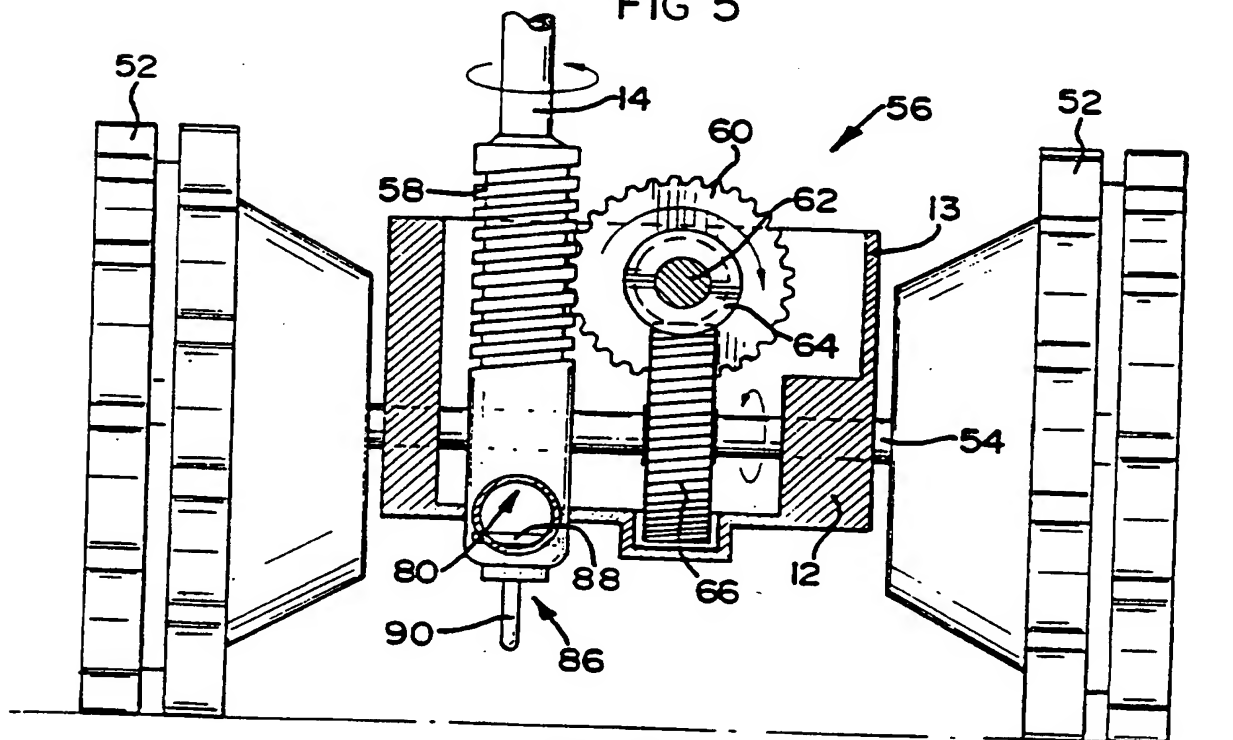
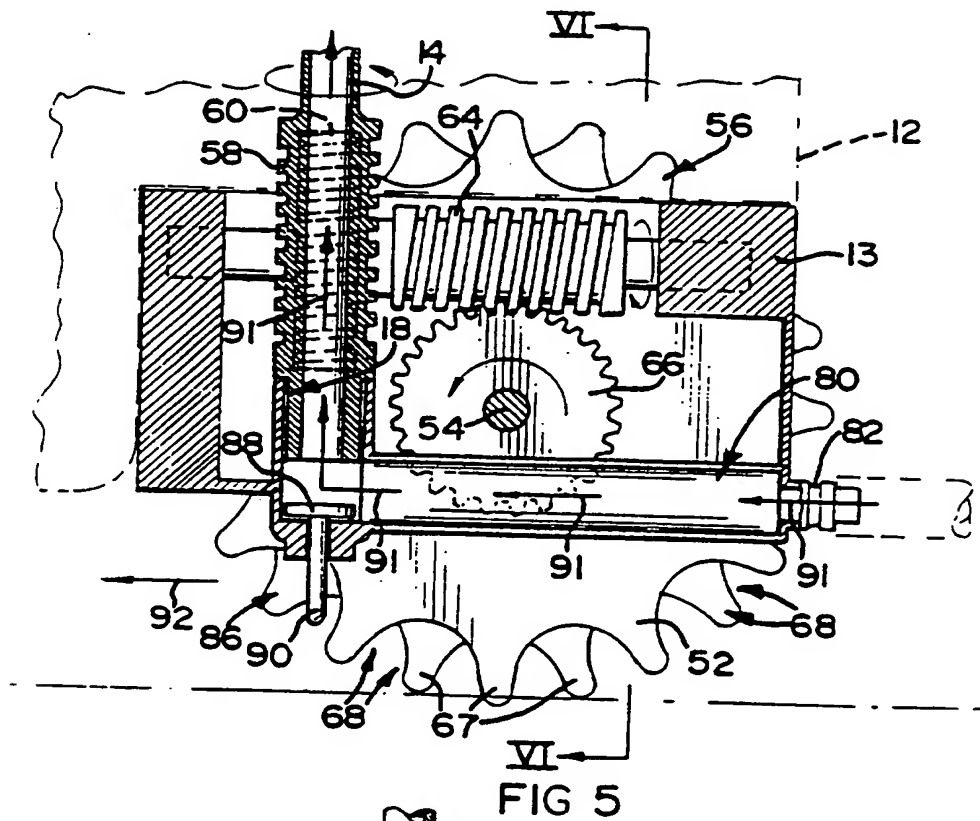


FIG 4

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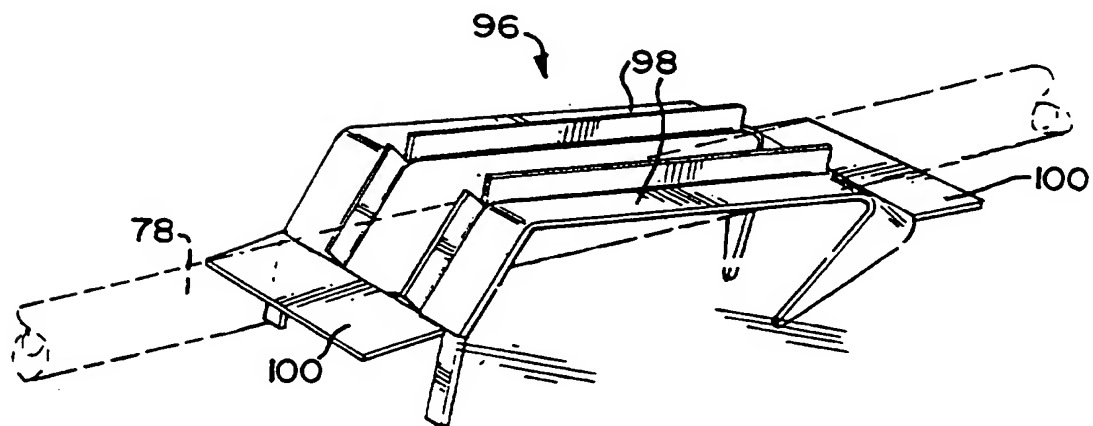


FIG 7

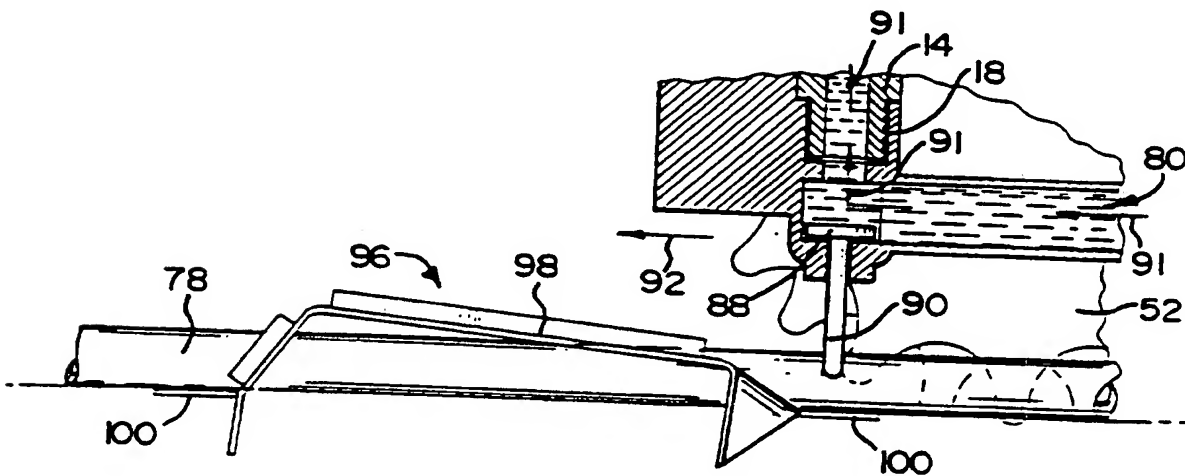


FIG 8

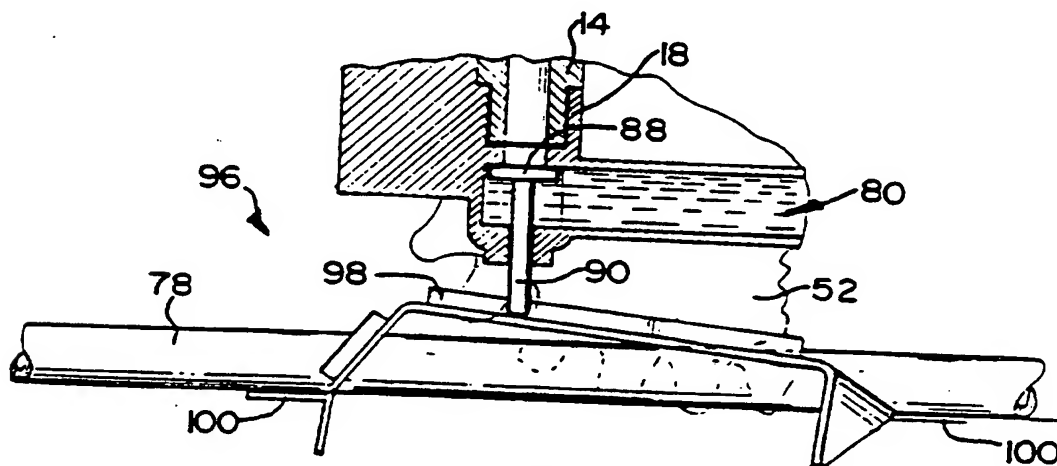
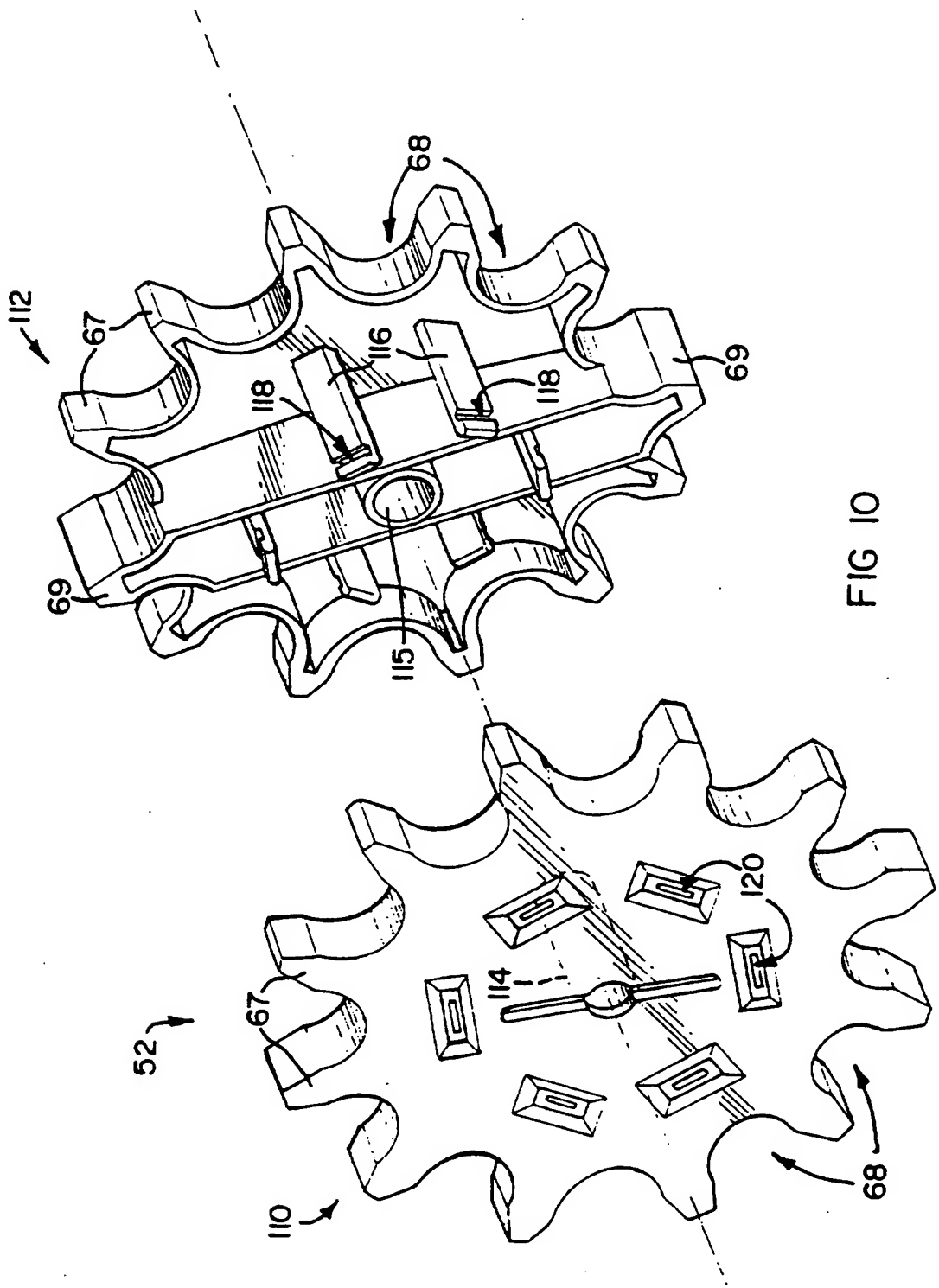


FIG 9

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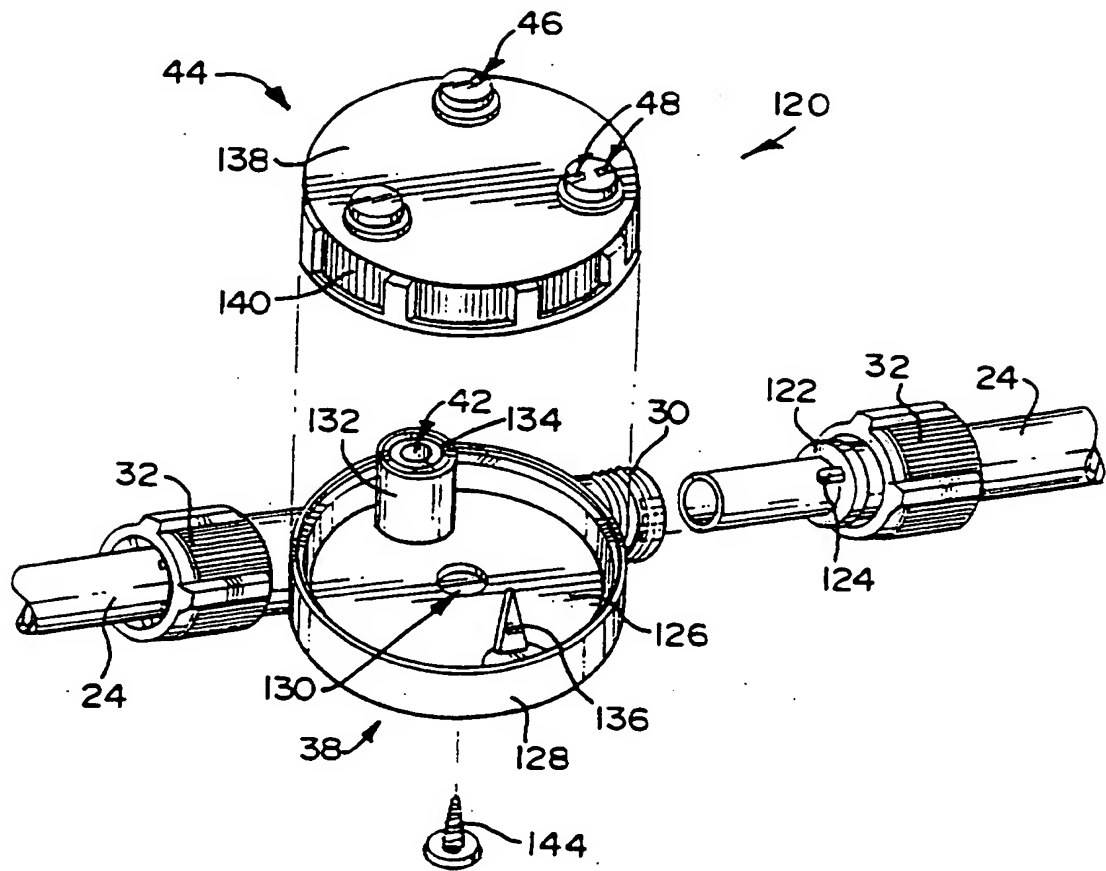


FIG 11

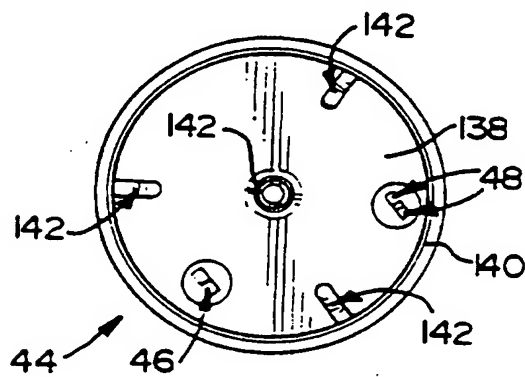


FIG 12

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/US96/01684

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) : B05B 3/18

US CL : 239/747

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 239/722, 743, 744, 747

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
NONEElectronic data base consulted during the international search (name of data base and, where practicable, search terms used)
NONE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category ^a	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US, A, 2,078,987 (Adamson) 04 May 1937 Note the speed control valve 20 on the reaction nozzles	1-18 and 22
Y	US, A, 3,085,751 (Warrick et al) 16 April 1963 See the bleed valve 84.	1-18 and 22
Y	US, A, 2,788,242 (Jepson) 09 April 1957 Note the worm gears 53 and 56	9
Y	US, A, 2,563,519 (Egly et al) 07 August 1951 Note the two gears 71.	18
A	US, A, 3,091,397 (Wynstra) 28 May 1963 Note the reaction nozzle drive 62.	NONE

☐ Further documents are listed in the continuation of Box C.
 ☐ See patent family annex.

^a Special categories of cited documents:	^T Documents published after the international filing date or priority date and are in conflict with the application but cited to inform the principles or theory underlying the invention.
^{*A} Document defining the general state of the art which is not considered to be of particular relevance.	^{*X} Document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone.
^{*E} Earlier document published on or after the international filing date.	^{*Y} Document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is considered with one or more other such documents, each constituting being obvious to a person skilled in the art.
^{*L} Document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (to be specified).	^{*A} Document member of the same patent family.
^{*O} Document referring to an oral disclosure, use, exhibition or other means.	
^{*P} Document published prior to the international filing date but later than the priority date claimed.	

Date of the actual completion of the international search

06 JUNE 1996

Date of mailing of the international search report

26 JUN 1996

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